Externalities

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What you will learn in this module

- What externalities are and why they can lead to inefficiency and government intervention in the market

- How negative, positive, and network externalities differ

- The importance of the Coase theorem, which explains how private individuals can sometimes remedy externalities

- Why some government policies to deal with externalities, like emissions taxes, tradable emissions permits, or Pigouvian subsidies, are efficient and others, like environmental standards, are not

- What makes network externalities an important feature of high-tech industries

External Costs and Benefits

- The environmental costs of pollution are the best known and most important example of an **external cost—**an uncompensated cost that an individual or firm imposes on others.

- Many examples of an external cost that an individual or firm imposes on others (example: texting while driving)

- Pollution leads to an external cost because in the absence of government intervention those who decide how much pollution to create have no incentive to take into account the costs of pollution that they impose on others.

- In the case of air pollution from a coal-fired power plant, the power company has no incentive to take into account the health costs imposed upon people who breathe dirty air.

- Instead, the company's incentives are determined by the private monetary costs and benefits of generating power, such as the price of coal, the price earned for a kilowatt of energy, and so on.

External Costs and Benefits

- There are also important examples of **external benefits,** benefits that individuals or firms confer on others without receiving compensation.
- For example, when you get a flu shot, you are less likely to pass on the flu virus to your roommates. Yet you alone incur the monetary cost of the vaccination and the painful jab.
- Businesses that develop new technologies also generate external benefits, because their ideas often contribute to innovation by other firms.
- External costs and benefits are jointly known as **externalities**
- External costs are called **negative externalities.**
- External benefits are called **positive externalities.**
- Externalities can lead to private decisions—that is, decisions by individuals or firms—that are not optimal for society as a whole.

Pollution: an external cost

- Pollution is a bad thing. Yet most pollution is a side effect of activities that provide us with good things: our air is polluted by power plants generating the electricity that lights our cities, and our rivers are damaged by fertilizer runoff from farms that grow our food.

- Why shouldn't we accept a certain amount of pollution as the cost of a good life? Actually, we do.

- Even highly committed environmentalists don't think that we can or should completely eliminate pollution—even an environmentally conscious society would accept *some* pollution as the cost of producing useful goods and services.

- What environmentalists argue is that unless there is a strong and effective environmental policy, our society will generate *too much* pollution—too much of a bad thing.

Pollution: an external cost

- To see why, we need a framework that lets us think about how much pollution a society *should* have.
- We'll then be able to see why a market economy, left to itself, will produce more pollution than it should.
- We'll start by adopting the simplest framework to study the problem—assuming that the amount of pollution emitted by a polluter is directly observable and controllable.
- We need to think in terms of **marginal social cost of pollution and marginal social benefit of pollution.**

Pollution: an external cost

- The **marginal social cost of pollution** is the **additional cost imposed on society as a whole** by an additional unit of pollution.

- For example, sulfur dioxide from coal-fired power plants mixes with rainwater to form acid rain, which damages fisheries, crops, and forests, or groundwater contamination, which may in turn damage health.

- Typically, the marginal social cost of pollution is increasing—each additional unit of pollution emitted causes a greater level of damage than the unit before. That's because nature can often safely handle low levels of pollution but is increasingly harmed as pollution reaches higher levels.

Pollution: an external cost

- The **marginal social benefit of pollution** is the **benefit to society from an additional unit of pollution**.

- This may seem like a confusing concept—how can there be any benefit to society from pollution? The answer lies in the understanding that pollution can be reduced—but at a cost.

- For example, air pollution from coal-fired power plants can be reduced by using more-expensive coal and expensive scrubbing technology; wastewater contamination of rivers and oceans can be reduced by building water treatment facilities.

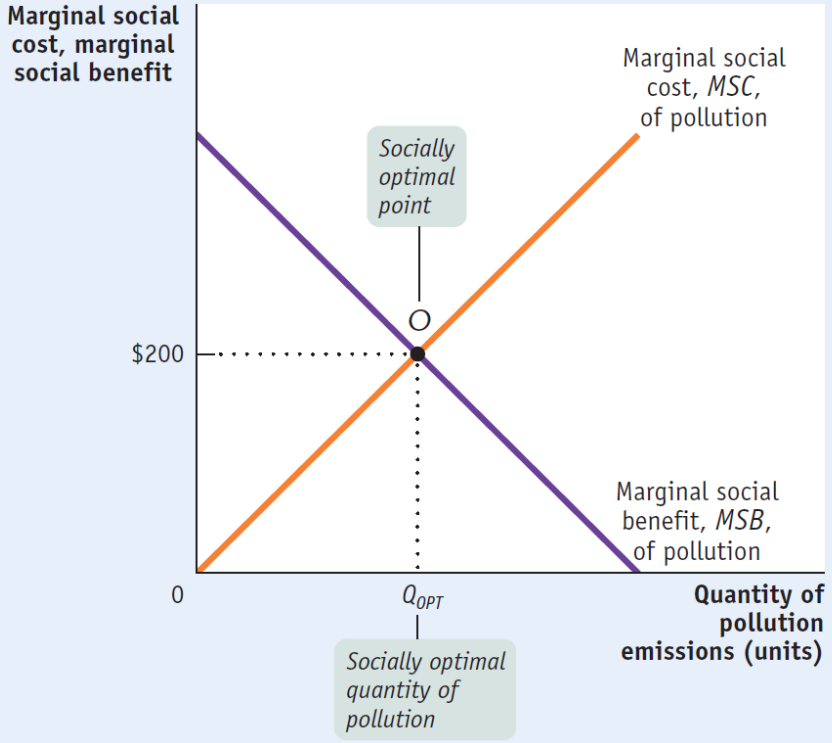
- All these methods of reducing pollution have an opportunity cost. That is, avoiding pollution requires using scarce resources that could have been employed to produce other goods and services.

- So the marginal social benefit of pollution is the goods and services that could be had by society if it tolerated another unit of pollution.

Socially optimal quantity of pollution

FIGURE 16-1 The Socially Optimal Quantity of Pollution

Pollution yields both costs and benefits. Here the curve *MSC* shows how the marginal cost to society as a whole from emitting one more unit of pollution emissions depends on the quantity of emissions. The *MSC* curve is upward sloping, so the marginal social cost increases as pollution increases. The curve *MSB* shows how the marginal benefit to society as a whole of emitting an additional unit of pollution emissions depends on the quantity of pollution emissions. The *MSB* curve is downward sloping, so the marginal social benefit falls as pollution increases. The socially optimal quantity of pollution is Q_{OPT}; at that quantity, the marginal social benefit of pollution is equal to the marginal social cost, corresponding to $200.



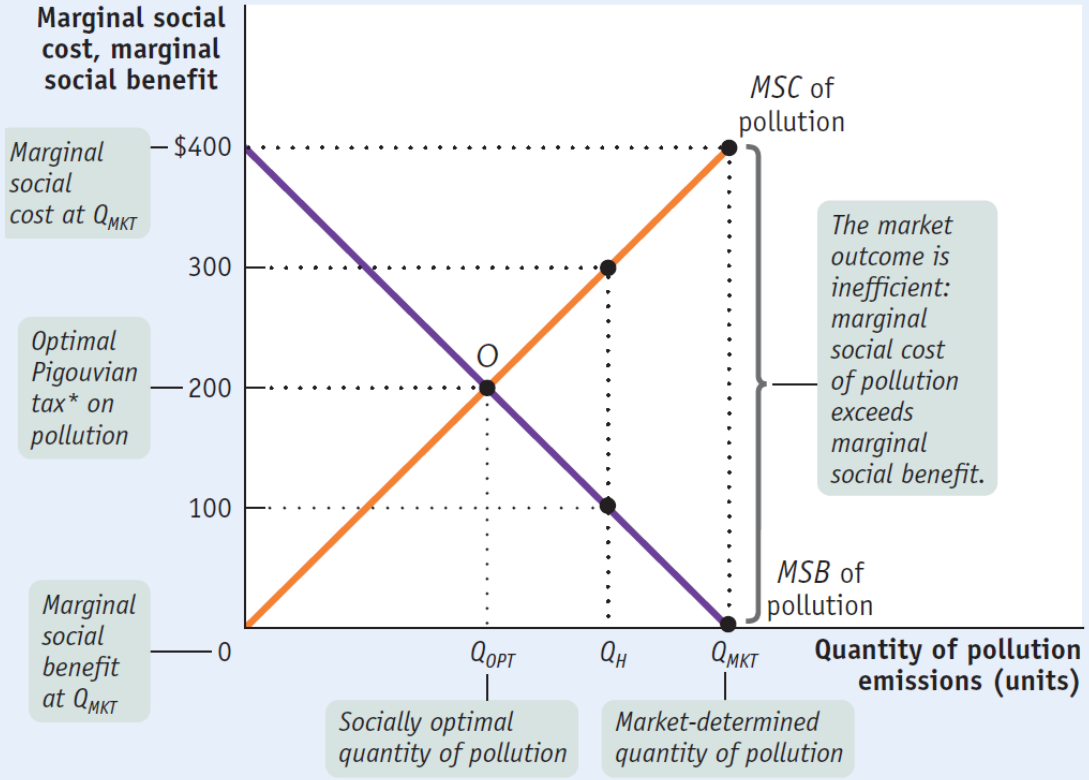
- The social optimal quantity of pollution isn't zero.
- But, will a market economy, left by itself, arrive at the social optimal quantity of pollution? **NO! It won't**

Why a market economy produces too much pollution

FIGURE 16-2 Why a Market Economy Produces Too Much Pollution

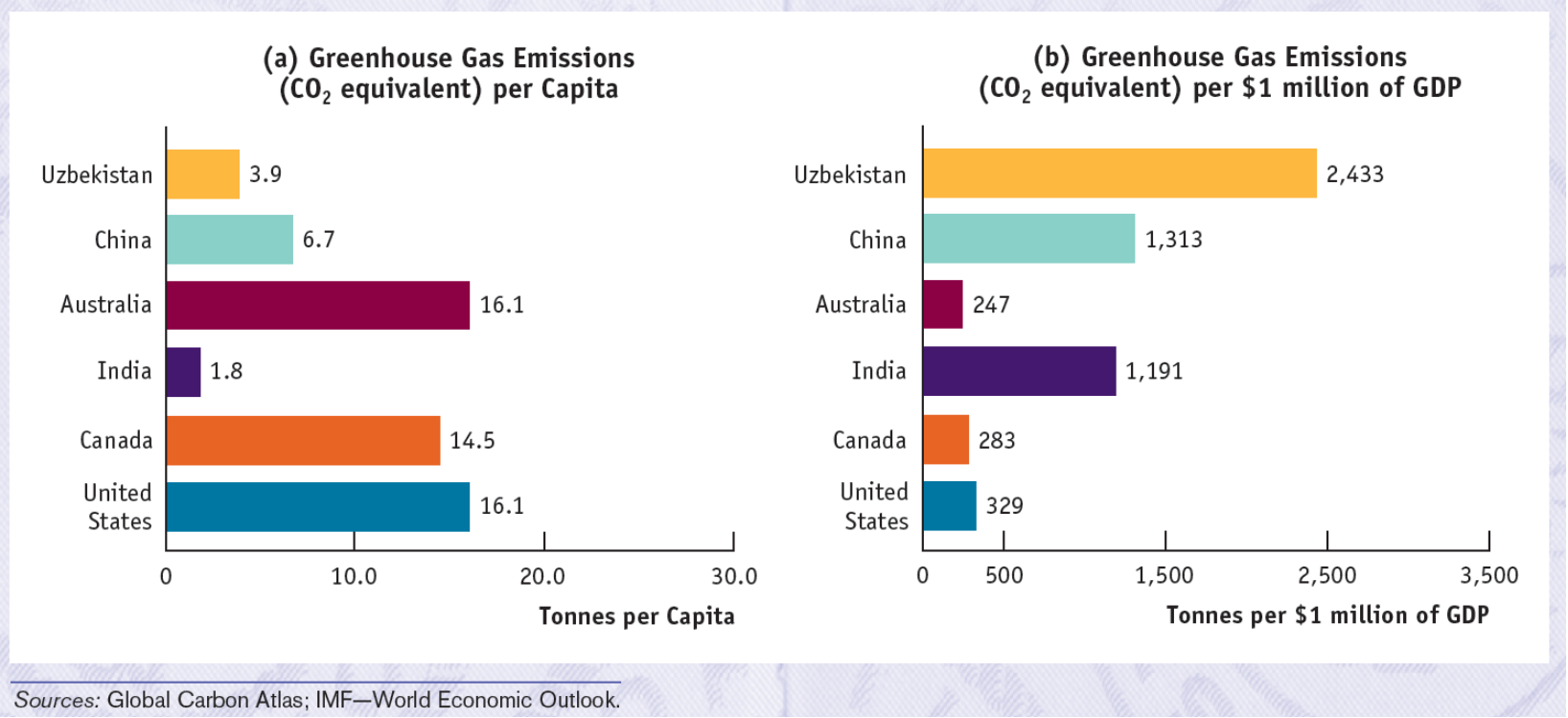
In the absence of government intervention, the quantity of pollution will be Q_{MKT}, the level at which the marginal social benefit of pollution is zero. This is an inefficiently high quantity of pollution: the marginal social cost, $400, greatly exceeds the marginal social benefit, $0. An optimal Pigouvian tax* of $200, the value of the marginal social cost of pollution when it equals the marginal social benefit of pollution, can move the market to the socially optimal quantity of pollution, Q_{OPT}.

Pigouvian taxes will be covered in the next section on pollution policy.



- The market outcome Q_{MKT} is inefficient!
- An outcome is inefficient if someone could be made better off without someone else being made worse off.

Economic Growth and Greenhouses gases in six countries



Sources: Global Carbon Atlas; IMF—World Economic Outlook.

Private solution to externalities

- Externalities in a market economy cause inefficiency: there is a mutually beneficial trade that is being missed. So can the private sector solve the problem of externalities without government intervention?

- In an influential 1960 article, the economist and Nobel laureate Ronald Coase pointed out that in an ideal world the private sector could indeed solve the problem of inefficiency caused by externalities.

- According to the **Coase theorem,** even in the presence of externalities an economy can always reach an efficient solution provided that the costs of making a deal are sufficiently low. The costs of making a deal are known as **transaction costs.**

- Consider the case of groundwater contamination caused by drilling. There are two ways a private transaction can address this problem:

1) First, landowners whose groundwater is at risk of contamination can pay drillers to use more-expensive, less-polluting technology.
2) Second, the drilling companies can pay landowners the value of damage to their groundwater sources—say, by buying their properties outright so that the landowners move.

Private solution to externalities

- What Coase argued is that, either way, if transaction costs are sufficiently low, then drillers and landowners can make a mutually beneficial deal. Regardless of how the transaction is structured, the social cost of the pollution is taken into account in decision making.

- When individuals take externalities into account when making decisions, economists say that they **internalize the externalities.**

- In this case the outcome is efficient without government interventions.

- **But are transaction costs really low?** Unfortunately, not

- *The high cost of communication.* Suppose a power plant emits pollution that covers a wide area. The cost of communicating with the many people affected will be very high.

- *The high cost of making legally binding and timely agreements.* What if some owners band together and pay a driller to reduce groundwater pollution. It can be very expensive to make an effective agreement, requiring lawyers, groundwater tests, engineers, and others.

Policies toward pollution

- Before 1970, there were no rules governing the amount of sulfur dioxide that coal-burning power plants in the United States could emit.
- When sulfur dioxide is emitted into the air, it mixes with water and produces sulfuric acid, which falls to earth as acid rain.
- Acid rain is as acidic as lemon juice and has killed fish in lakes over a wide swath of the northeastern United States, damaged trees and crops, and in time even began to dissolve limestone buildings.
- In 1970, Congress adopted the Clean Air Act, which set rules forcing power plants to reduce their emissions. And it worked—the acidity of rainfall declined significantly.
- Economists, however, argued that a more flexible system of rules that exploits the effectiveness of markets could reduce pollution at a lower cost.
- In 1990 this theory was put into effect with a modified version of the Clean Air Act. And guess what? The economists were right!

Policies towards pollution

- We will analyze different policies governments use to deal with pollution and we will see how economic analysis has been used to improve those policies.

1) **Environmental Standards**

2) **Emissions Taxes**

3) **Tradable Emission Permits**

- We then compare the different policies with an example.

Environmental Standards

- At present the main policy tools are **environmental standards,** rules that protect the environment by specifying actions by producers and consumers. A familiar example is the law that requires almost all vehicles to have catalytic converters, which reduce the emission of chemicals that can cause smog and lead to health problems.

- Other rules require communities to treat their sewage or factories to avoid or limit certain kinds of pollution.

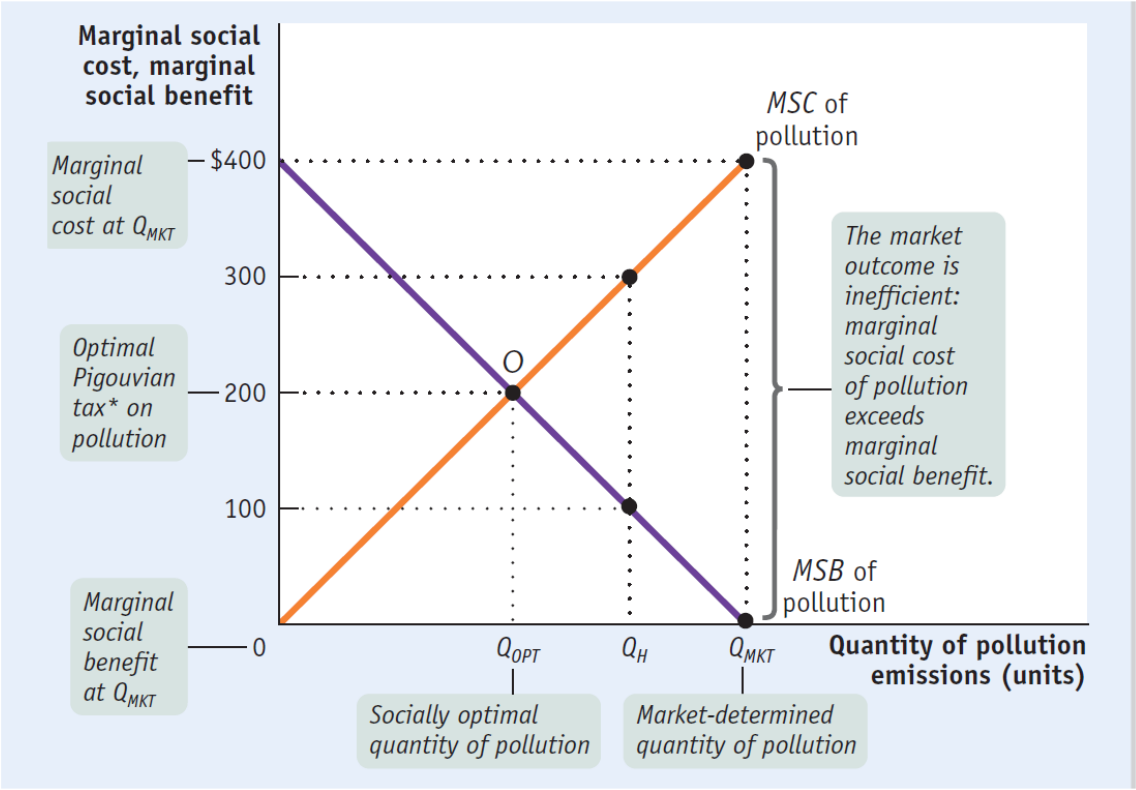
- Environmental standards came into widespread use in the 1960s and 1970s, and they have had considerable success in reducing pollution.

- For example, since the United States passed the Clean Air Act in 1970, overall emission of pollutants into the air has fallen by more than a third, even though the population has grown by a third and the size of the economy has more than doubled.

- Even in Los Angeles, still famous for its smog, the air has improved dramatically: in 1976 ozone levels in the South Coast Air Basin exceeded federal standards on 194 days; in 2013, on only 5 days.

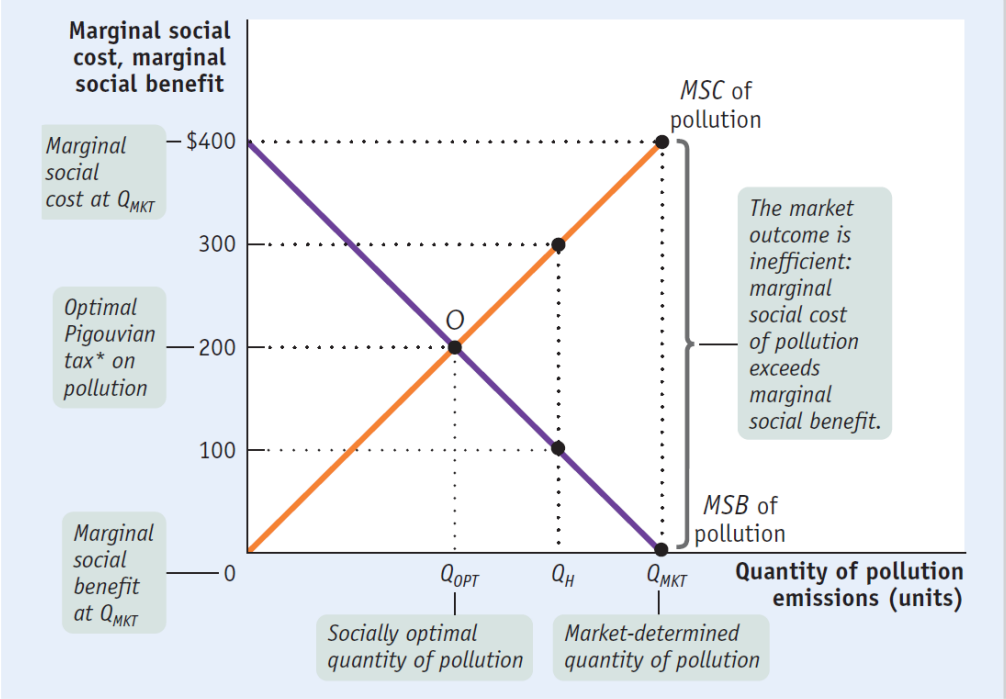
Emission Taxes

- Another way to deal with pollution directly is to charge polluters an **emissions tax. <u>Emissions taxes are taxes that depend on the amount of pollution a firm emits.</u>**
- A tax imposed on an activity will reduce the level of that activity. Looking again at Figure 16-2, we can find the amount of tax on emissions that moves the market to the socially optimal point.



Emission Taxes

- It's now easy to see how an emissions tax can solve the problem.
- If polluters are required to pay a tax of $200 per unit of pollution, they now face a marginal cost of $200 per unit and have an incentive to reduce their emissions to Q_{OPT}, the socially optimal quantity.
- This illustrates a general result: **an emissions tax equal to the marginal social cost at the socially optimal quantity of pollution induces polluters to internalize the externality**—to take into account the true cost to society of their actions.



Emission Taxes

- In general, taxes designed to reduce external costs are known as **Pigouvian taxes,** after the economist A. C. Pigou, who emphasized their usefulness in his classic 1920 book, *The Economics of Welfare.*

- In our example, the optimal Pigouvian tax is $200. As you can see from Figure 16-2, this corresponds to the marginal social cost of pollution at the optimal output quantity Q_{OPT}.

- Are there any problems with emissions taxes? The main concern is that in practice government officials usually aren't sure how high the tax should be set.

- If they set it too low, there won't be sufficient reduction in pollution.

- If they set it too high, emissions will be reduced by more than is efficient.

- This uncertainty around the optimal level of the emissions tax can't be eliminated, but the nature of the risks can be changed by using an alternative policy, issuing tradable emissions permits.

Tradable Emissions Permits

- **Tradable emissions permits are licenses to emit limited quantities of pollutants that can be bought and sold by polluters.**

- Firms that pollute typically have different costs of reducing pollution—for example, it will be more costly for plants using older technology to reduce pollution than plants using newer technology.

- Regulators begin the system by issuing polluters with permits to pollute based on some formula—say, for example, equal to 50% of a given firm's historical level of emissions.

- Firms then have the right to trade permits among themselves. Under this system, a market in permits to pollute will emerge.

- Polluters who place a higher value on the right to pollute—those with older technology—will purchase permits from polluters who place a lower value on the right to pollute—those with newer technology.

Tradable Emissions Permits

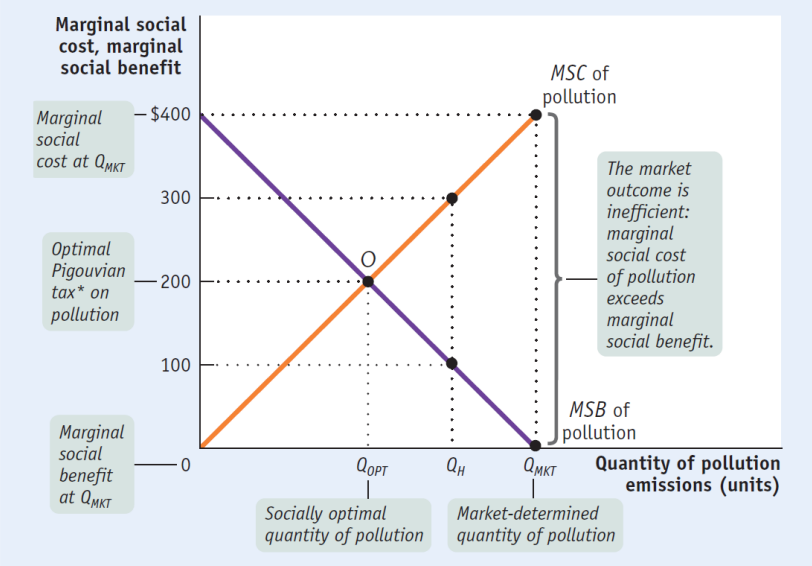
- As a result, a polluter with a higher value for a unit of emissions will pollute more than a polluter with a lower value.

- In the end, those with the lowest cost of reducing pollution will reduce their pollution the most, while those with the highest cost of reducing pollution will reduce their pollution the least.

- The total effect is to allocate pollution reduction efficiently—that is, in the least costly way.

Tradable Emissions Permits

- Just like emissions taxes, tradable emissions permits provide polluters with an incentive to take the marginal social cost of pollution into account.
- To see why, suppose that the market price of a permit to emit one unit of pollution is $200.
- Every polluter now has an incentive to limit its emissions to the point where its marginal benefit of one unit of pollution is $200. Why?
- If the marginal benefit of one more unit of pollution is greater than $200 then it is cheaper to pollute more than to pollute less. In that case the polluter will buy a permit and emit another unit.
- If the marginal benefit of one more unit of pollution is less than $200, then it is cheaper to reduce pollution than to pollute more. In that scenario the polluter will reduce pollution rather than buy the $200 permit.



Tradable Emissions Permits

- From this example we can see how an emissions permit leads to the same outcome as an emissions tax when they are the same amount.
- A polluter who pays $200 for the right to emit one unit faces the same incentives as a polluter who faces an emissions tax of $200 per unit.
- And it's equally true for polluters that have received more permits from regulators they plan to use: by not emitting one unit of pollution, a polluter frees up a permit that it can sell for $200.
- In other words, the opportunity cost of a unit of pollution to this firm is $200, regardless of whether it is used.

Tradable Emissions Permits

- Recall that when using emissions taxes to arrive at the optimal level of pollution, the problem arises of finding the right amount of the tax: if the tax is too low, too much pollution is emitted; if the tax is too high, too little pollution is emitted.

- A similar problem with tradable emissions permits is getting the quantity of permits right, which is much like the flip-side of getting the level of the tax right.

- Because it is difficult to determine the optimal quantity of pollution, regulators can find themselves either issuing too many permits, so that there is insufficient pollution reduction, or issuing too few, so that there is too much pollution reduction.

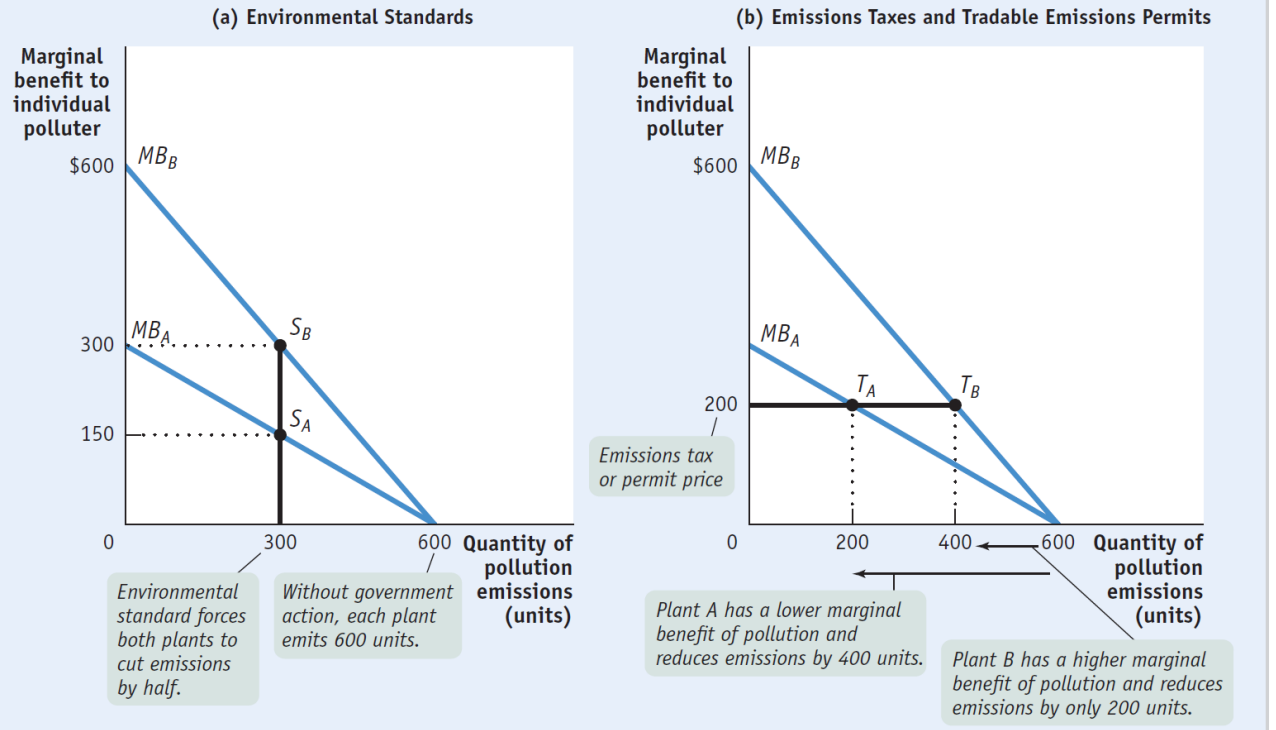
- In the case of sulfur dioxide pollution, the U.S. government first relied on environmental standards, but then turned to a system of tradable emissions permits.

- Currently the largest emissions permit trading system is the **European Union system for controlling emissions of carbon dioxide**.

Comparing Environmental Policies

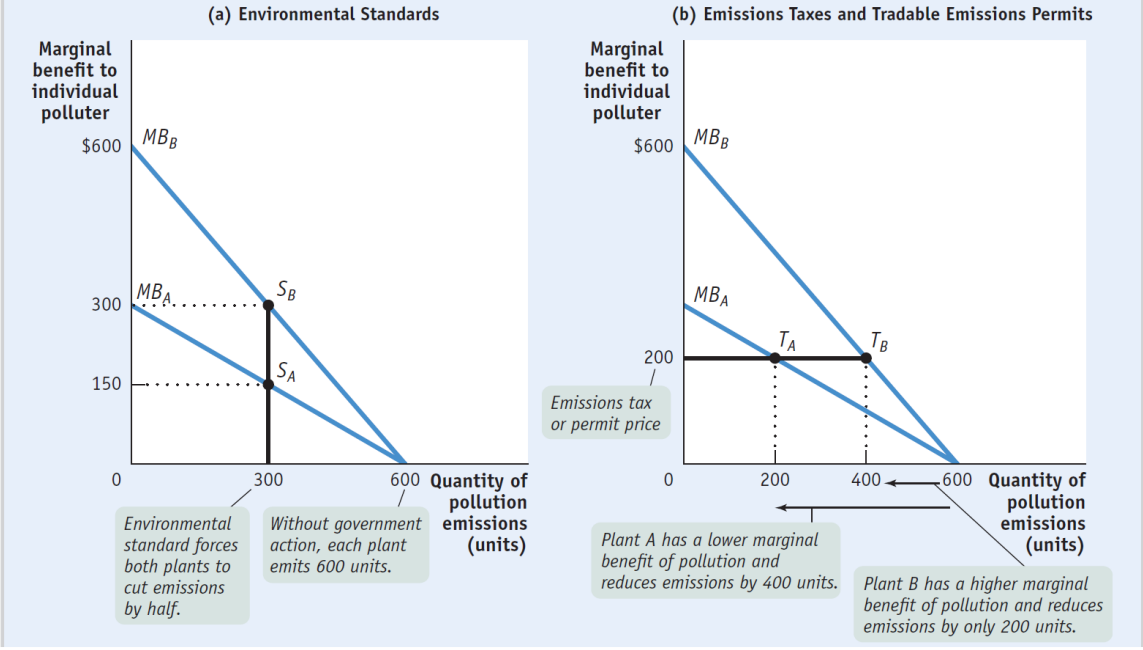
- Figure 16-3 shows a hypothetical industry consisting of only two plants.
- Plant A uses newer technology, giving it a lower cost of pollution reduction, while plant B uses older technology and has a higher cost of pollution reduction.
- Reflecting this difference, plant A's marginal benefit of pollution curve, MB_A, lies below plant B's marginal benefit of pollution curve, MB_B. Because it is more costly for plant B to reduce its pollution at any output quantity, an additional unit of pollution is worth more to plant B than to plant A.

FIGURE 16-3 Comparing Environmental Policies



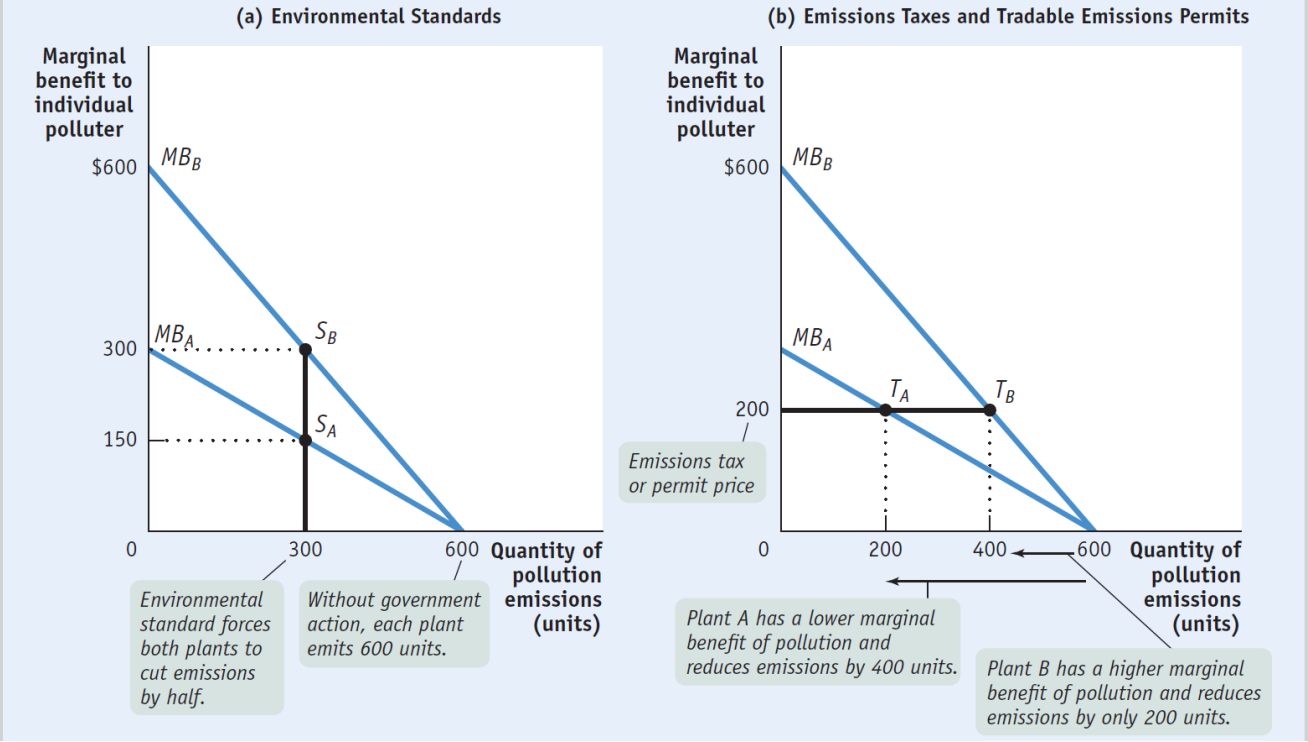
Comparing Environmental Policies

- In the absence of government action, we know that polluters will pollute until the marginal social benefit of a unit of pollution is equal to zero.
- As a result, without government intervention each plant will pollute until its own marginal benefit of pollution is equal to zero. This corresponds to an emissions quantity of 600 units for each plant—the quantities of pollution at which MB_A and MB_B are equal to zero.
- So although plant A and plant B have different costs of pollution reduction, they will each choose to emit the same amount of pollution.



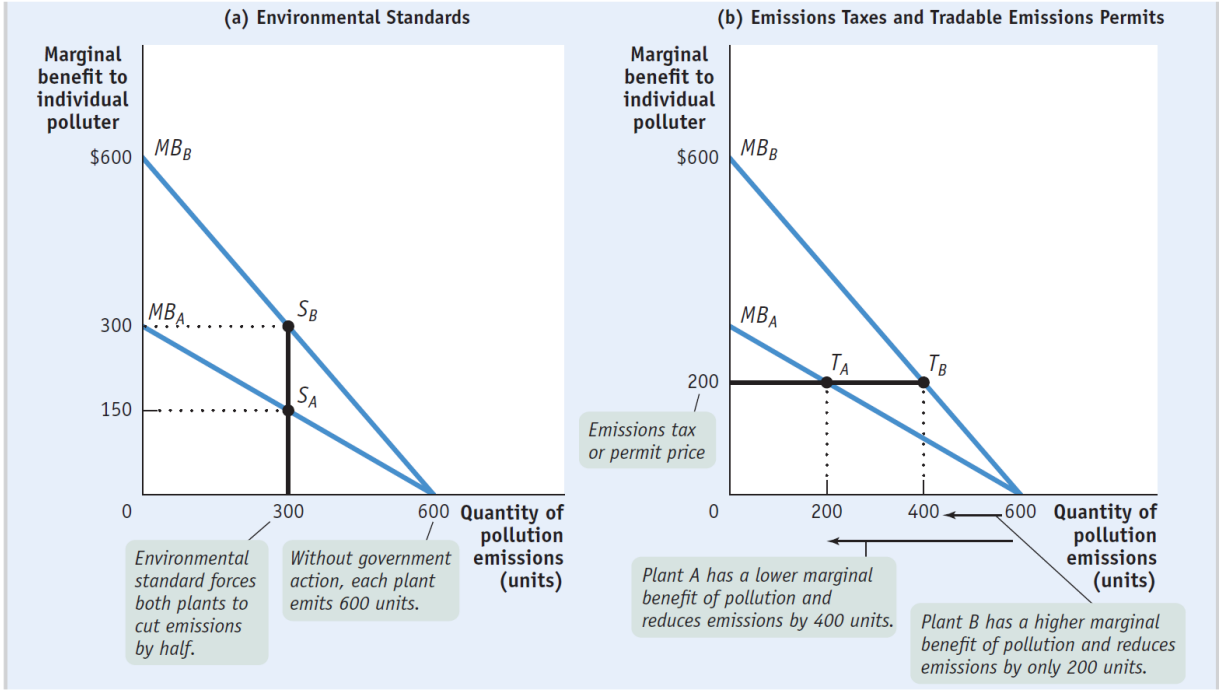
Comparing Environmental Policies

- Now suppose that regulators decide that the overall pollution from this industry should be cut in half, from 1,200 units to 600 units.
- Panel (a) of Figure 16-3 shows this might be achieved with an environmental standard that requires each plant to cut its emissions in half, from 600 to 300 units.
- The standard has the desired effect of reducing overall emissions from 1,200 to 600 units but accomplishes it inefficiently



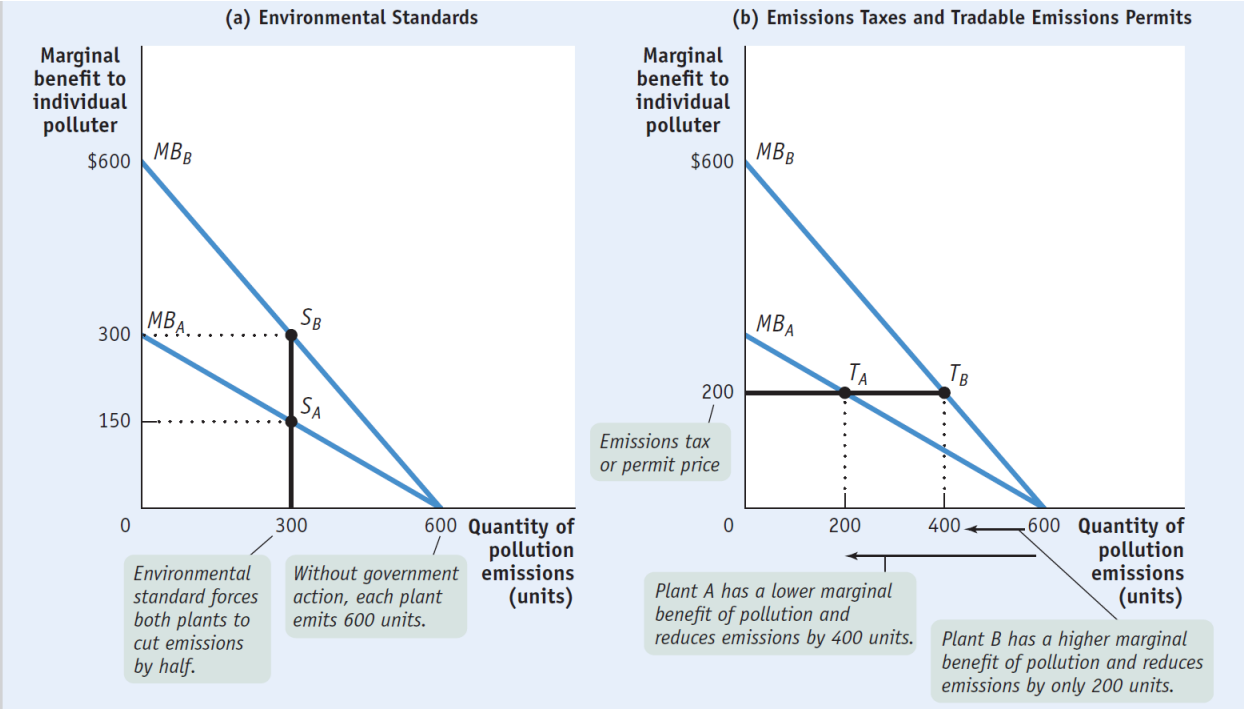
Comparing Environmental Policies

- The environmental standard leads plant A to produce at point *SA,* where its marginal benefit of pollution is $150, but plant B produces at point *SB,* where its marginal benefit of pollution is twice as high, $300.
- This difference in marginal benefits between the two plants tells us that the same quantity of pollution can be achieved at lower total cost by allowing plant B to pollute more than 300 units but inducing plant A to pollute less.
- In fact, the efficient way to reduce pollution is to ensure that at the industry-wide outcome, the marginal benefit of pollution is the same for all plants.



Comparing Environmental Policies

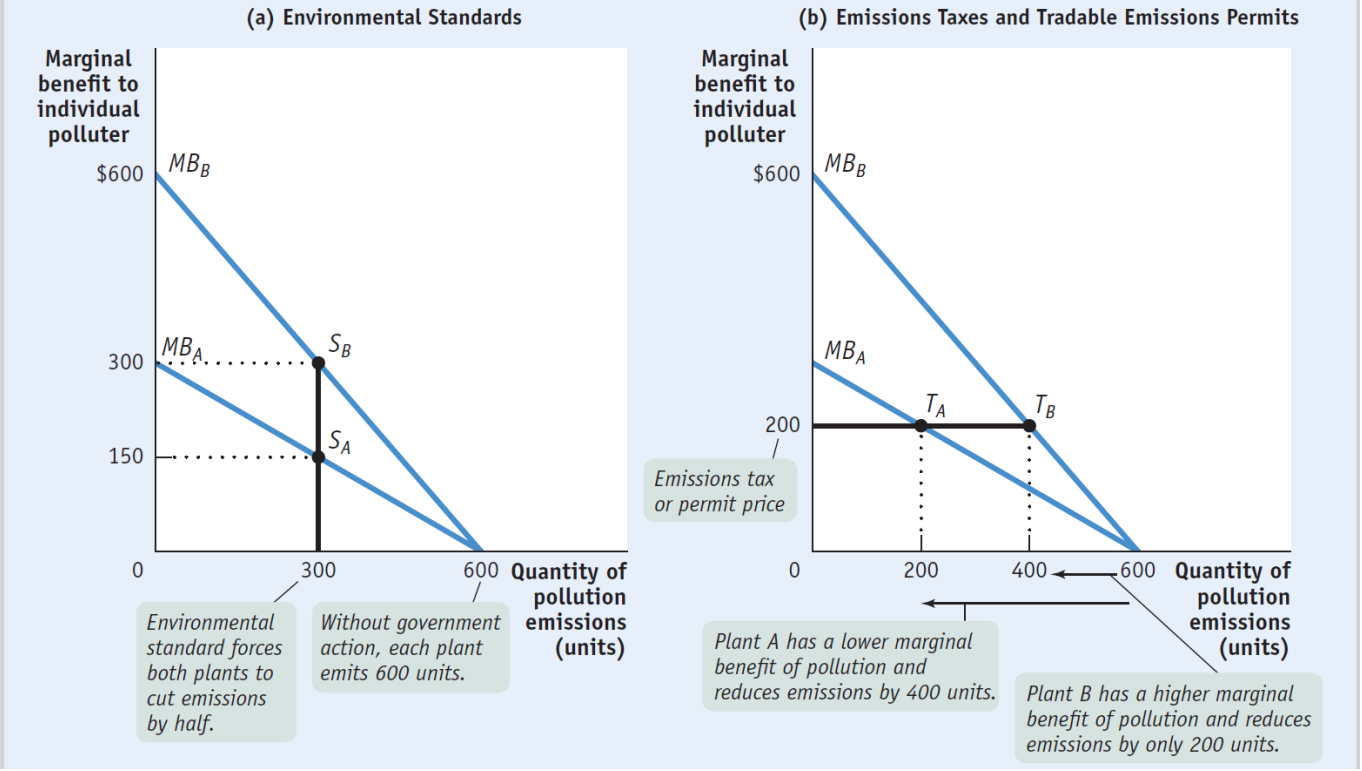
- We can see from panel (b) how an emissions tax achieves exactly that result.
- Suppose both plant A and plant B pay an emissions tax of $200 per unit, so that the marginal cost of an additional unit of emissions to each plant is now $200 rather than zero.
- As a result, plant A produces at T_A and plant B produces at T_B.
- So plant A reduces its pollution more than it would under an inflexible environmental standard, cutting its emissions from 600 to 200 units; meanwhile, plant B reduces its pollution less, going from 600 to 400 units.



Comparing Environmental Policies

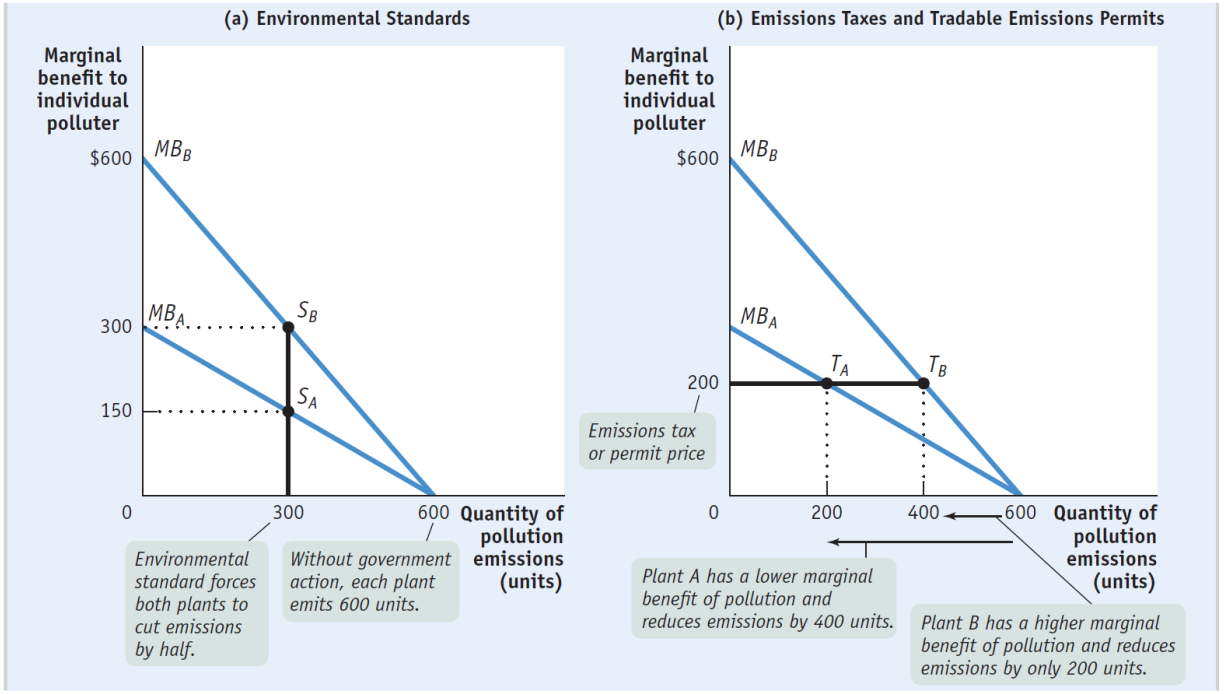
- In the end, total pollution - 600 units - is the same as under the environmental standard, but total surplus is higher.

- That's because the reduction in pollution has been achieved efficiently, allocating most of the reduction to plant A, the plant that can reduce emissions at lower cost.



Comparing Environmental Policies

- Panel (b) also illustrates why a system of tradable emissions permits also achieves an efficient allocation of pollution among the two plants.
- Assume that in the market for permits, the market price of a permit is $200 and each plant has 300 permits to start the system.
- Plant B, with the higher cost of pollution reduction, will buy 200 permits from Plant A, enough to allow it to emit 400 units.
- Correspondingly, Plant A, with the lower cost, will sell 200 of its permits to Plant B and emit only 200 units.



Positive Externalities

- Economic activities not necessarily lead to negative externalities: they might also produce positive externalities, i.e. external benefits.

- Example: in 1961, New Jerseyans have voted in a series of measures that subsidize farmers to permanently preserve their farmland rather than sell it to developers.

- By 2013, the Green Acres Program, administered by the state, had preserved over 640,000 acres of open space.

- Why have New Jersey citizens voted to raise their own taxes to subsidize the preservation of farmland? Because they believe that preserved farmland in an already heavily developed state provides external benefits, such as natural beauty, access to fresh food, and the conservation of wild bird populations.

- In addition, preservation alleviates the external costs that come with more development, such as pressure on roads, water supplies, and municipal services—and, inevitably, more pollution.

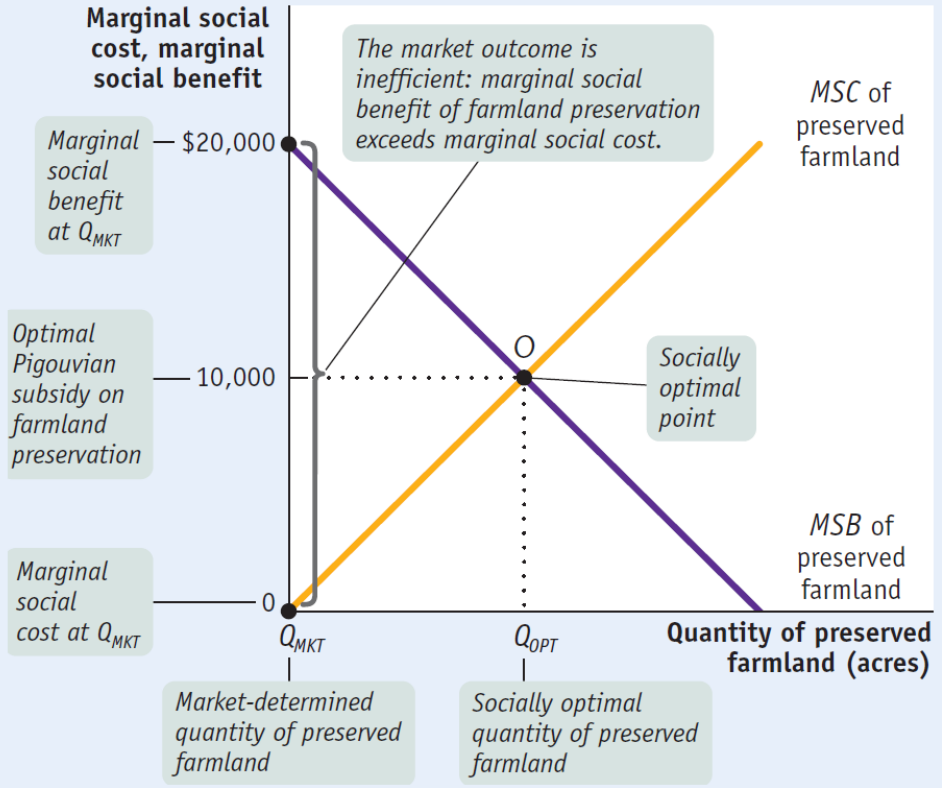
Positive Externalities

- Preserved farmland yields both benefits and costs to society.
- In the absence of government intervention, the farmer who wants to sell his land incurs all the costs of preservation—namely, the forgone profit to be made from selling the farmland to a developer.
- But the benefits of preserved farmland accrue not to farmer but to neighboring residents, who have no right to influence how the farmland is disposed of.
- We can describe this situation in terms of marginal social cost of preserved farmland, *MSC*, and marginal social benefit, MSB.
- The MSC is the additional cost imposed on society by an additional acre of such farmland. This represents the forgone profits that would have accrued to farmers if they had sold their land to developers.
- The *MSB* is the additional benefit that accrues to society—in this case, the farmer's neighbors—when an additional acre of farmland is preserved.

Positive Externalities

FIGURE 16 -4 Why a Market Economy Preserves Too Little Farmland

Without government intervention, the quantity of preserved farmland will be zero, the level at which the marginal social cost of preservation is zero. This is an inefficiently low quantity of preserved farmland: the marginal social benefit is $20,000, but the marginal social cost is zero. An optimal Pigouvian subsidy of $10,000, the value of the marginal social benefit of preservation when it equals the marginal social cost, can move the market to the socially optimal level of preservation, Q_{OPT}.



- The socially optimal point, *O,* occurs when the marginal social cost and the marginal social benefit are equalized
- The market alone will not provide Q_{OPT} acres of preserved farmland. Instead, in the market outcome no acres will be preserved

Positive Externalities

- Because farmers bear the entire cost of preservation but gain none of the benefits, an inefficiently low quantity of acres will be preserved in the market outcome.
- This is clearly inefficient because at zero acres preserved, the marginal social benefit of preserving an acre of farmland is $20,000.
- So how can the economy be induced to produce Q_{OPT} acres of preserved farmland, the socially optimal level?
- The answer is a **Pigouvian subsidy:** a payment designed to encourage activities that yield external benefits.
- The optimal Pigouvian subsidy, as shown in Figure 16-4, is equal to the marginal social benefit of preserved farmland at the socially optimal level, Q_{OPT}—that is, $10,000 per acre.
- So New Jersey voters are indeed implementing the right policy to raise their social welfare—taxing themselves in order to provide subsidies for farmland preservation.

Positive Externalities of Education

- One of the most vexing problems facing any society is how to break the “cycle of poverty”.
- Children who grow up in disadvantaged socioeconomic circumstances are far more likely to remain trapped in poverty as adults, even after we account for differences in ability.
- They are more likely to be unemployed or underemployed, to engage in crime, and to suffer chronic health problems.
- Early-childhood intervention has offered some hope of breaking the cycle.
- A study by the RAND Corporation found that high-quality early-childhood programs that focus on education and health care lead to significant social, intellectual and financial advantages for kids who would otherwise be at risk of dropping out of high school and of engaging in criminal behavior.
- Children in programs like Head Start were less likely to engage in such destructive behaviors and more likely to end up with a job and to earn a high salary later in life.

Positive Externalities of Education

- Another study by researchers at the University of Pittsburgh looked at early-childhood intervention programs from a dollars-and-cents perspective.
- It finds benefits from $4 to $7 for every $1 spent on early-childhood intervention programs.
- A Rand study put the figure as high as $17 per $1 spent.
- The Pittsburgh study also pointed to one program whose participants, by age 20, were 26% more likely to have finished high school, 35% less likely to have been charged in juvenile court, and 40% less likely to have repeated a grade compared to individuals of similar socioeconomic background who did not attend preschool.
- The observed external benefits to society of these programs are so large that the Brookings Institution predicts that providing high-quality preschool education to every American child would result in an increase in GDP (the total value of a country domestic output) by almost 2%, representing over 3 million more jobs.

Positive Externalities of Cash Transfers Programs

- Over the past twenty years, a growing number of developing countries have launched social protection programs.

- Most of the programs in Latin America provide cash transfers conditional on meeting certain requirements (e.g. Progresa, Opportunitades, Prospera in Mexico)

- On the contrary, the majority of the cash transfer programs in African countries are unconditional: vulnerable households receive money without having to meet requirements in terms of schooling, or health care uptake.

https://www.youtube.com/watch?v=L5Dodpt5TKQ&list=PLPPqmSbMGwbXyJGFi_46hb747cKgPkxH6&index=1

- Social protection programs targeted to poor households have positive spillovers on the local economy: they affect not only the direct beneficiaries but also non-poor households living in the same communities.

https://transfer.cpc.unc.edu/

Network Externalities

- A *network externality* exists when the value of a good or service is greater when a large number of other people also use the good or service.

- Network externalities are common in technology driven and communication-driven sectors of the economy. However, the phenomenon is more widespread than that.

- Consider the case of a car. You might not think that the value of having a car depends on how many others also have cars, but in the early days of car consumerism it certainly did. That's because when very few cars existed, service stations and repair shops were few and far between, and local governments had little or no incentive to upgrade their roads.

- However, as more people purchased cars, service stations and repair shops sprang up and roads were improved. As a result, owning a car became even more valuable.

- What a network externality shares with positive and negative externalities is an external effect: one person's actions affect the payoff to another person's actions. Network externalities play a key role both in the economy and in a number of regulatory policy controversies.

Network Externalities

- The classic case of network externalities in the high-tech industry arises from computer operating systems.

- Most personal computers around the world run on Windows by Microsoft rather than on Apple's competing system.

- In 2013, 18.8 new PCs that run Windows were sold for every Apple Mac sold. Why does Windows dominate personal computers?

- There are two channels, both involving network externalities:

1) a direct effect: it is easier for a Windows user to get help and advice from other Windows users;
2) an indirect effect: Window's early dominance attracted more software developers, so more programs were developed to run on Windows than on a competing system. (This second effect has largely vanished now, but it was important early on in making PCs dominant.)

Network Externalities

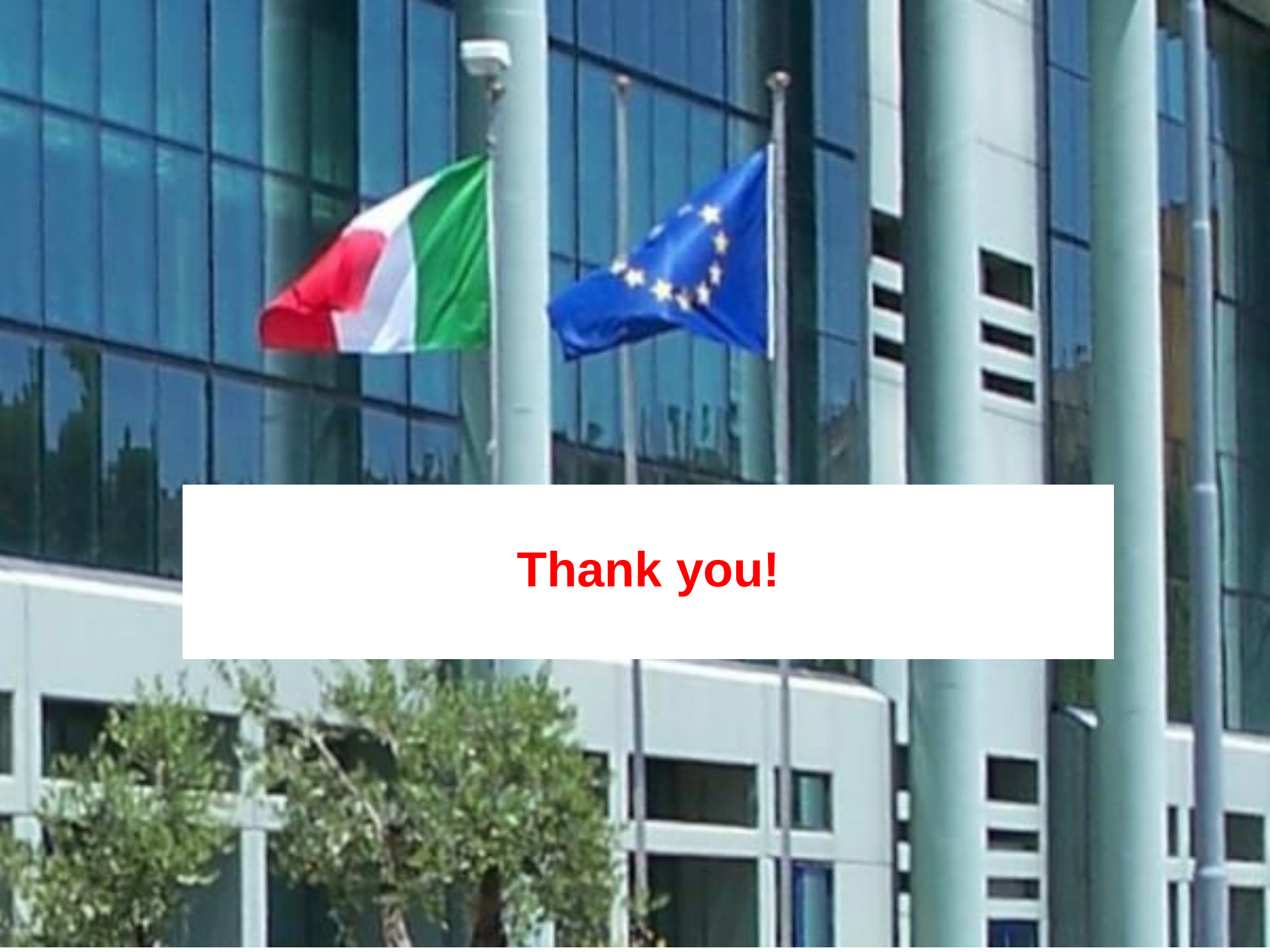
- Network externalities present special challenges for antitrust regulators because the antitrust laws do not, strictly speaking, forbid monopoly.

- Rather, they only prohibit *monopolization*—efforts to create a monopoly. If you just happen to end up ruling an industry, that's OK, but if you take actions designed to drive out competition, that's not OK.

- So we could argue that monopolies in goods with network externalities, because they occur naturally, should not pose legal problems.

- Unfortunately, it isn't that simple. Firms investing in new technologies are clearly trying to establish monopoly positions.

- Furthermore, in the face of positive feedback, firms have an incentive to engage in aggressive strategies to push their goods in order to increase their network size and tip the market in their favor.



Thank you!